

## ABSTRACT

## MULTIVARIATE STATISTICAL PROCESS MONITORS

An extended partial least squares (EPLS) approach for the condition monitoring of industrial processes is described. This EPLS approach provides two statistical monitoring charts to detect abnormal process behaviour as well as contribution charts to diagnose this behaviour. A theoretical analysis of the EPLS monitoring charts is provided, together with two application studies to show that the EPLS approach is either more sensitive or provides easier interpretation than conventional PLS.

- 10 Generalised scores are calculated by constructing an augmented matrix, of the form

$$\mathbf{Z} = [\mathbf{Y} : \mathbf{X}],$$

- where  $\mathbf{X}$  is the predictor matrix and  $\mathbf{Y}$  is the response matrix, and constructing a score matrix  $\mathbf{T}_n^* = \mathbf{T}_n^* - \mathbf{E}_n^*$  in which  $\mathbf{T}_n^*$  and  $\mathbf{E}_n^*$  are  
15 generally of the form:

$$\mathbf{T}_n^* = [\mathbf{Y} : \mathbf{X}] [\mathbf{B}_{\text{PLS}}^{(n)} : \mathbf{I}]^{\dagger} \mathbf{R}_n$$

$$\mathbf{E}_n^* = [\mathbf{E}_n : \mathbf{F}_n] [\mathbf{B}_{\text{PLS}}^{(n)} : \mathbf{I}]^{\dagger} \mathbf{R}_n$$

the columns of the matrix  $\mathbf{T}_n^*$  providing the generalised t-scores and the columns of the matrix  $\mathbf{E}_n^*$  the generalised residual scores, where  $\mathbf{I}$  denotes an  $M \times M$  identity matrix,

$\mathbf{B}_{\text{PLS}}^{(n)}$  is the PLS regression matrix.

Figure 4